UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

DATE: JAN 14 1992

SUBJECT: ACS NPL Site
Groundwater Modeling

FROM: Dr. Luanne Vanderpool, Geologist
Technical Support Section

TO: Wayde Hartwick, RPM
IL/IN RRS #2

Eileen Helmer asked that I review the Groundwater Modeling Results, Appendix A, of the Draft Feasibility Study for American Chemical Services (ACS) NPL Site. The Feasibility Study has stated on page 3-18, "Groundwater extraction associated with the pump and treat system would not be expected to affect wetlands hydrology based on modeling results presented in Appendix A." Eileen asked me to determine if this statement is true.

In attempting to answer Eileen's question, I discovered the presentation of the groundwater modeling in Appendix A to be confusing and incomplete, lacking much of the supporting explanation and rationale that should be included with any modeling report. Consequently, I am including specific comments which identify some of the gaps in the modeling report. A comprehensive review of the groundwater modeling may be appropriate. (I understand there was a review of the modeling in the RI done by the Indiana District of the USGS; perhaps they might be contacted.) The following are my comments for your consideration.

Upper Aquifer Remediation Simulation

1. It should be clearly stated if this is a steady state or a transient modeling application. It appears that both types were done.

2. Was calibration done to only the steady state model or also for the transient? The calibration should have been evaluated by some quantitative criteria; was it? The results of the calibration testing should be given. There should be a graphic comparison of real and modeled water levels. It is too much to expect us to accept the results of this modeling when there is no evidence given that the simulation model comes close to fitting the actual data.

I qualitatively compared the heads portrayed in the "steady state non-remediation flow conditions map to the water table levels in Figure 1-12 of the FS. There are large deviations between the two maps in the southwest and the north. There are smaller (but still significant deviations) to the east. Why is the fit so poor? Such a poor fit seriously compromises the subsequent modeling credibility.

3. In the discussion of sensitivity testing, it is stated that "doubling and quadrupling the hydraulic conductivity had relatively little effect on the water table distribution." How little? This should be quantified.

4. It is stated that hydraulic conductivity varies across the modeled area. How does it vary? In some fashion, the report must include this information. A map contoured to show the input hydraulic conductivity values would be an effective portrayal.

   According to the text on page 2, hydraulic conductivity varies from 10^{-3} to 10^{-4} cm/sec. However Table 1 indicates the range as 8.5×10^{-4} to 8.5×10^{-3} (which is nearly 10^{-3} to 10^{-2}); this is nearly an order of magnitude different. Why the discrepancy?

5. It is stated on the bottom of page 2 that it was assumed that 1 foot of precipitation recharges the water table (ie is infiltration). In Table 1, it is stated that the model was calibrated using 4 inches per year of infiltration. Then in Table 2, Summary of Output, the infiltrating precipitation is given as 1 ft/year (or 2 ft/year). Why this discrepancy?

6. There are 6 remediation simulations listed on page 3. Why are so many presented? Obviously one purpose was to consider the effect having (REM1, REM2, REM3, and REM6) or omitting a slurry wall (REM4 and REM5). However, there are simulations listed with varying permeability values and different infiltration values. What are the conclusions to these various runs? Is one set of input parameters preferable? A water level map is only presented for REM2 of the various slurry wall runs; does this imply that REM2 is the "best" model?

7. Table 1 gives the boundary conditions (b.c.). Specifically what are they? For boundaries that are specified head, what is the head? If the b.c. discharge, what is the assumed flow? What are GHB cells? All the boundary conditions should be explained in english (not just in modeling jargon) and the boundary conditions should be justified in terms of site specific hydrogeology.

Table 1 states "Column 30 is constant head boundary (IBOUND < 1)". My understanding is that for constant head boundaries, the MODFLOW parameter IBOUND should be < 0.

What are the initial head values? A map or table should show these. Table 1 states that initial head values were developed from a steady state solution to run 3. What is run 3? Is that the same as REM3? Justification should be supplied for whatever initial heads were used.

8. What is the justification for a specific yield value of 0.25? Is it reasonable for this parameter to be constant when hydraulic conductivity and grain size vary across the site? Was there any sensitivity testing and calibration testing for this parameter?

9. Table 1 states that the bottom elevation for the aquifer in the Upper Aquifer Remediation Simulation was set at 620 ft msl. While the elevation of the base of the upper aquifer may average around 620 ft msl, according to Figures 1-7 through Figure 1-10 of the FS, the elevation of the base of the aquifer varies. What is the impact of setting this parameter to a constant value? Is the model at all sensitive to this parameter?

10. In Table 1, in the section titled Discharge Areas, there is reference to ACS.* runs and REM.* runs. What are these; there has been no other mention of ACS runs.

    In this section of the table, it is stated "level set at 627 ft msl, field measured value". To what grid cell or cells does this apply?

11. In Table 1, in the section titled Recharge Areas, there is mention of a "coefficient of 20" and a "coefficient of 2". What are these and how are they used?

12. Table 2 is a summary of output. The copy of the FS I am reviewing duplicates the information on REM1 and REM2 from the first page of the table on the second page.

    There is no summary of output from REM6. Why is it omitted from this table (and from the Summed Extraction Rate Plot and the Water Level Plot)?

13. What is the head listed in Table 2? Is the head measured at a specific grid cell? If so, which one? Or is the head the average head within the slurry wall zone or is the head the lowest water level within the slurry wall zone? Or is head something else?

14. Finite Difference Grid for Modflow Figure
Why isn't this figure oriented the same as the other figures for the modeling? It is confusing to try to orient the various figures. This figure and all the maps need north arrows.

What is the significance of the shaded cells in this figure? What are the numbers in the cells shown in this figure; are they values of IBOUND? This figure's legend should answer these questions.

15. Steady-State Non-Remediation Flow Conditions Figure
This Figure has a subtitle of ACS - 4. It apparently does not represent the output of any of the REM1 through REM6 simulation runs. What are the input parameters for this run?

16. 90 Days, No Slurry Wall Figure
Which REM is represented by this figure, REM4 or REM5?

Lower Aquifer Remediation Simulation

17. What is the rationale and justification for assigning the value of the storativity and vertical conductivity parameters?

18. There is no discussion of sensitivity testing or calibration testing for this simulation. Just as this is required for the upper aquifer simulations, it must be documented for the lower aquifer simulations. This is particularly important for the parameters that are not supported by site specific measurements (storativity and vertical conductivity).

19. Apparently, the simulation of the lower aquifer is assuming that there is no connection at all between the upper aquifer and the lower aquifer since the two aquifers are de-coupled and are being modeled separately. However, on page 1-12 of the FS, vertical gradients are discussed indicating the potential for vertical leakage from the upper aquifer to the lower. How is the model of the lower aquifer allowing for the potential recharge into it from the upper aquifer? If this effect is being ignored, what is the impact on the results?

20. Thickness of the lower aquifer is assumed to be 60 feet. Is this supported by field data? The cross sections in the FS do not indicate the bottom of this aquifer.

21. The Appendix states that all the outer rows and columns were set to constant head values. I question the appropriateness of this. Generally, assigning all boundaries cells to constant head values over-constrains the model and artificially impacts the results. Was this problem considered?

Northwest Area Groundwater Modeling

22. It is stated that the groundwater model remediation implementation REM4 was used. Does this mean that all the input parameters were the same in the Northwest Area modeling as in the REM4 upper aquifer simulation? The text in this section specifically discuses the aquifer thickness and hydraulic conductivity of the northwest area. Is this information being used to modify any of the modeling input values? Were the 12 extraction wells pumped as in REM4?

23. The explanation for the differing orientations of Figures A and B is appreciated. Better would be if the orientations were not different. There are various drawing programs which could rotate one.

Wetlands Impact

My original purpose in looking at the groundwater modeling was to determine if the model supported the conclusion that wetlands hydrology would not be impacted by groundwater extraction. Despite the statements in the body of the FS indicating that modeling results in the Appendix indicated no wetlands impact, there is no discussion in the Appendix about wetlands and resulting changes to the water levels of the wetlands. Based on the modeling results in the FS, the following is my analysis.

The modeling report in Appendix A omits any map which shows the modeling grid in relation to the surface water features around the site. Attached is a copy of a figure from the RI (Ecological Features) with the approximate extent of the groundwater modeling grid outlined on it (Figure 1). The same area was modeling in both the upper aquifer modeling and the northwest area remediation modeling. As can be seen from the attached figure, Wetland II, located west of ACS, is outside the modeling area; and no conclusions about this area can be made based on the models. Similarly, the western half of Wetland I is beyond the modeling and no conclusions can be made. Conclusions are only possible for the eastern half of Wetland I and the Upland Hardwoods area east of the site.

The "Steady-state Non-Remediation Flow Conditions" map may be compared to maps showing the upper aquifer remediation scenarios modeled after 365 days (see attached Figures 2 and 3). Interestingly, the western half of the modeled Wetland I has a higher water table (up to over 2 feet) under the remediation scenarios. The eastern portion of this wetland has a lower water table (up to 2 feet head difference) under the remediation scenarios. In the case of the no slurry wall alternative, the zone of lowered water table in Wetland I is larger than for the alternative with the slurry wall. The water table is lowered in

the Upland Hardwoods area also; the area impacted is larger for the non-slurry wall alternative.

Comparing the groundwater model results to the water table map of April 6, 1990 (Figure 1-12) yields the following conclusions (see attached Figures 4 and 5). Water levels are higher for both the slurry wall alternative and the no slurry wall alternative in Wetlands I. Modeled water levels (with and without the slurry wall) are lower in the Upland Hardwoods area.

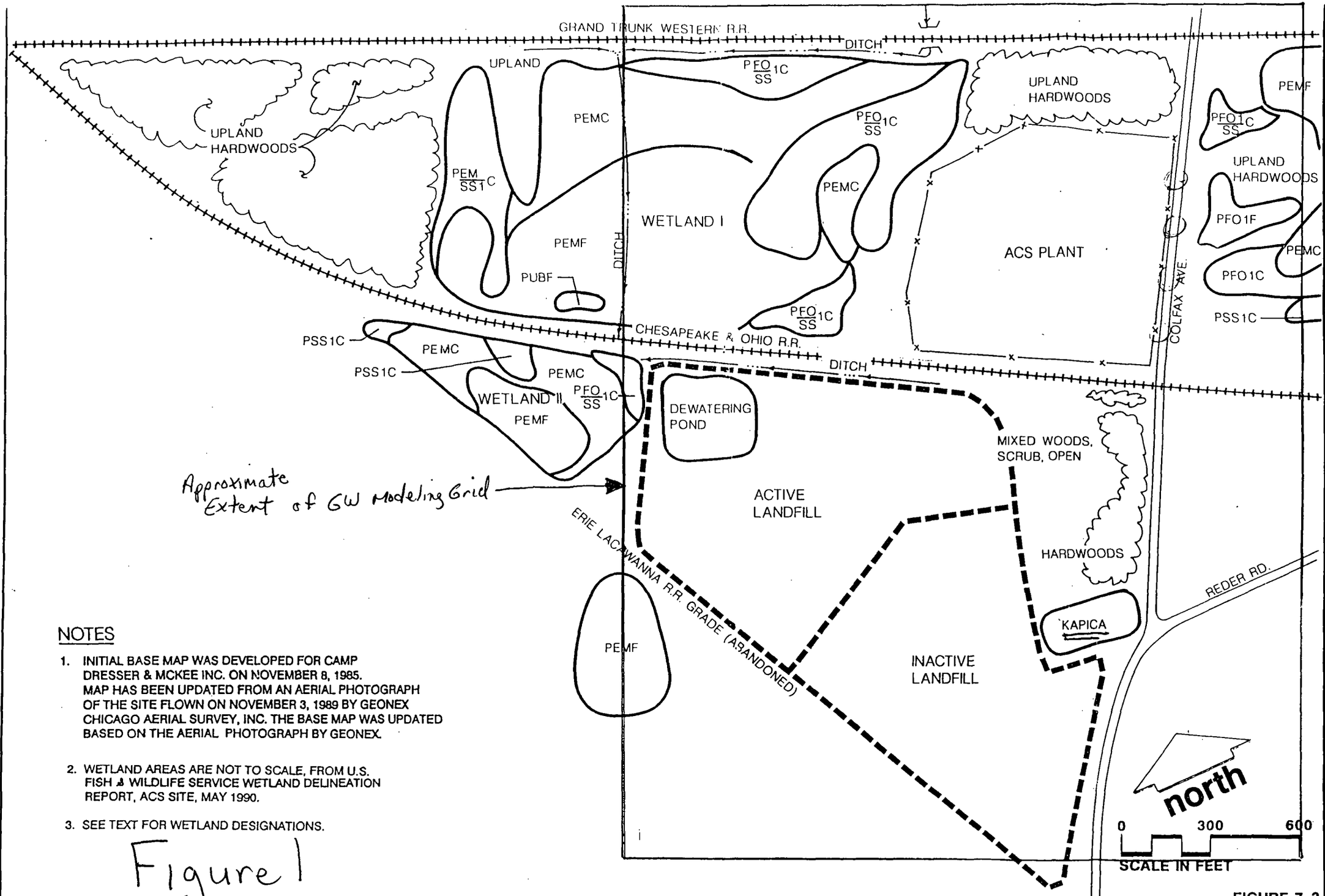
Overall, I can not agree that the modeling results indicate that the wetlands will not be affected. Some areas of the wetlands are not within the modeled area; for those the modeling says nothing. In those cases where the wetlands are within the modeled area, water levels are changed in the pumping scenarios.

I find it of some concern that modeled water levels under a pumping alternative (with or without a slurry wall) are so much higher than measured water levels in Wetland I. Common sense would suggest that the impact of groundwater withdrawal would be to lower water levels, not elevate water levels up to 3 feet. I suspect this difference in water levels is largely a reflection of poor calibration in the modeling of this area (and possibly incorrect boundary conditions), not a real effect due to the groundwater pumping.

Due to the number of problems in the models itemized above, I am uncomfortable assuming that conclusions based upon the groundwater modeling are substantiated. Until the supporting model rationale, justifications, and details of calibration and sensitivity testing are incorporated, any conclusions remain suspect.

I hope the above comments and analysis are of assistance to you. If you have questions, or require further assistance, you may reach me at 3-9296. Attached is a copy of the TSS critique form. I would appreciate it if you would complete the form and return it.

c.c. S. Ostrodka (w/o attachments)
C.C. E. Helmer



NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC. ON NOVEMBER 8, 1985. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. WETLAND AREAS ARE NOT TO SCALE, FROM U.S. FISH & WILDLIFE SERVICE WETLAND DELINEATION REPORT, ACS SITE, MAY 1990.
3. SEE TEXT FOR WETLAND DESIGNATIONS.

Figure 1

FIGURE 7-3

Created By: JFK
Date: 1-28-91
Drawn By: JC
Designed By:
Approved By: Jenny Kelly
Revised
Date • By • Appd
WARZYN ENGINEERING INC.
Revisions

ECOLOGICAL FEATURES MAP

REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Sheet Number 1 OF 1
Project Number 60251 B7
WARZYN

No slurry wall

STEADY-STATE NON-REMEDIATION FLOW CONDITIONS

No Slurry Wall

ACS – 4

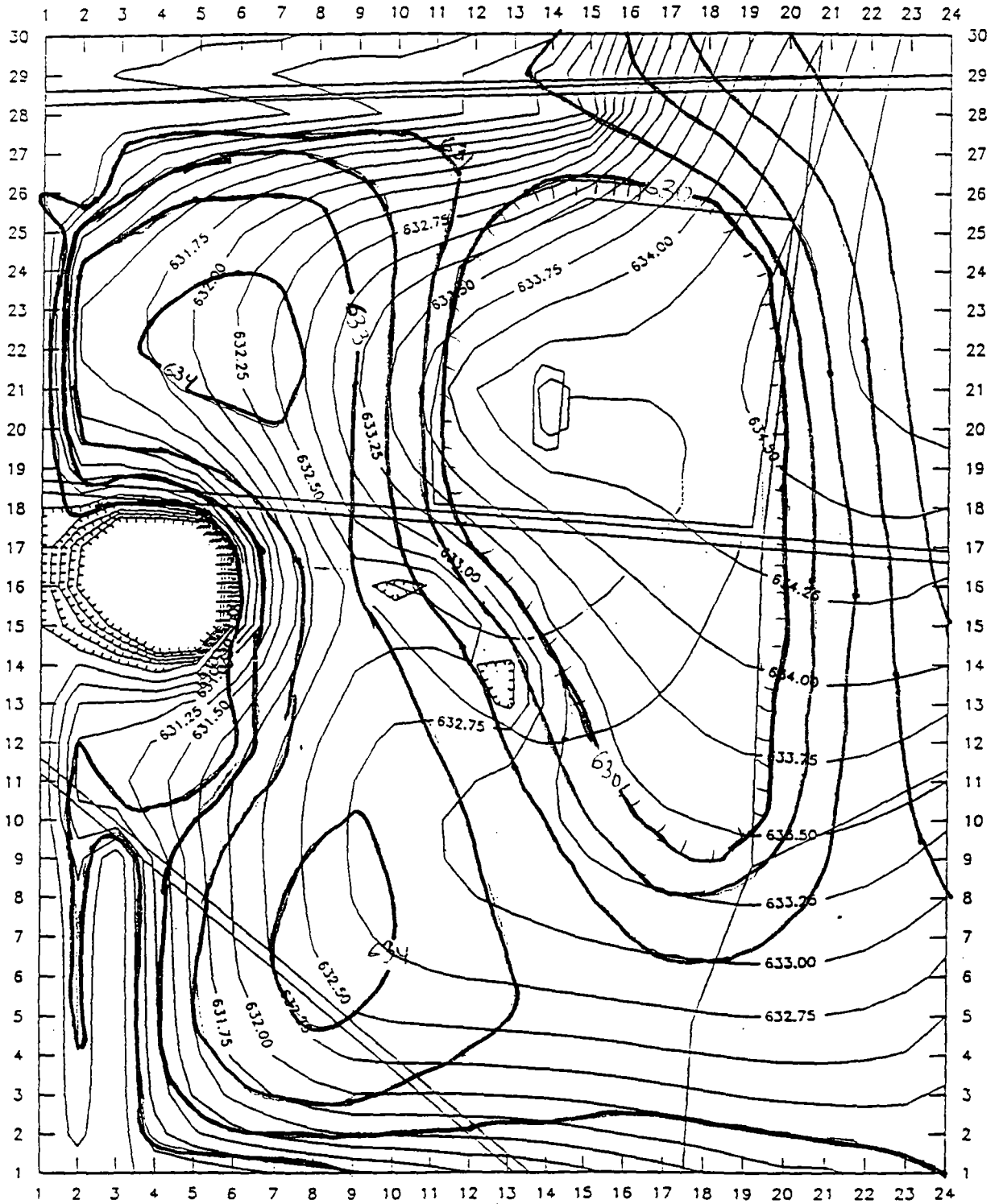


Figure 2

STEADY-STATE NON-REMEDIATION FLOW CONDITIONS

ACS – 4

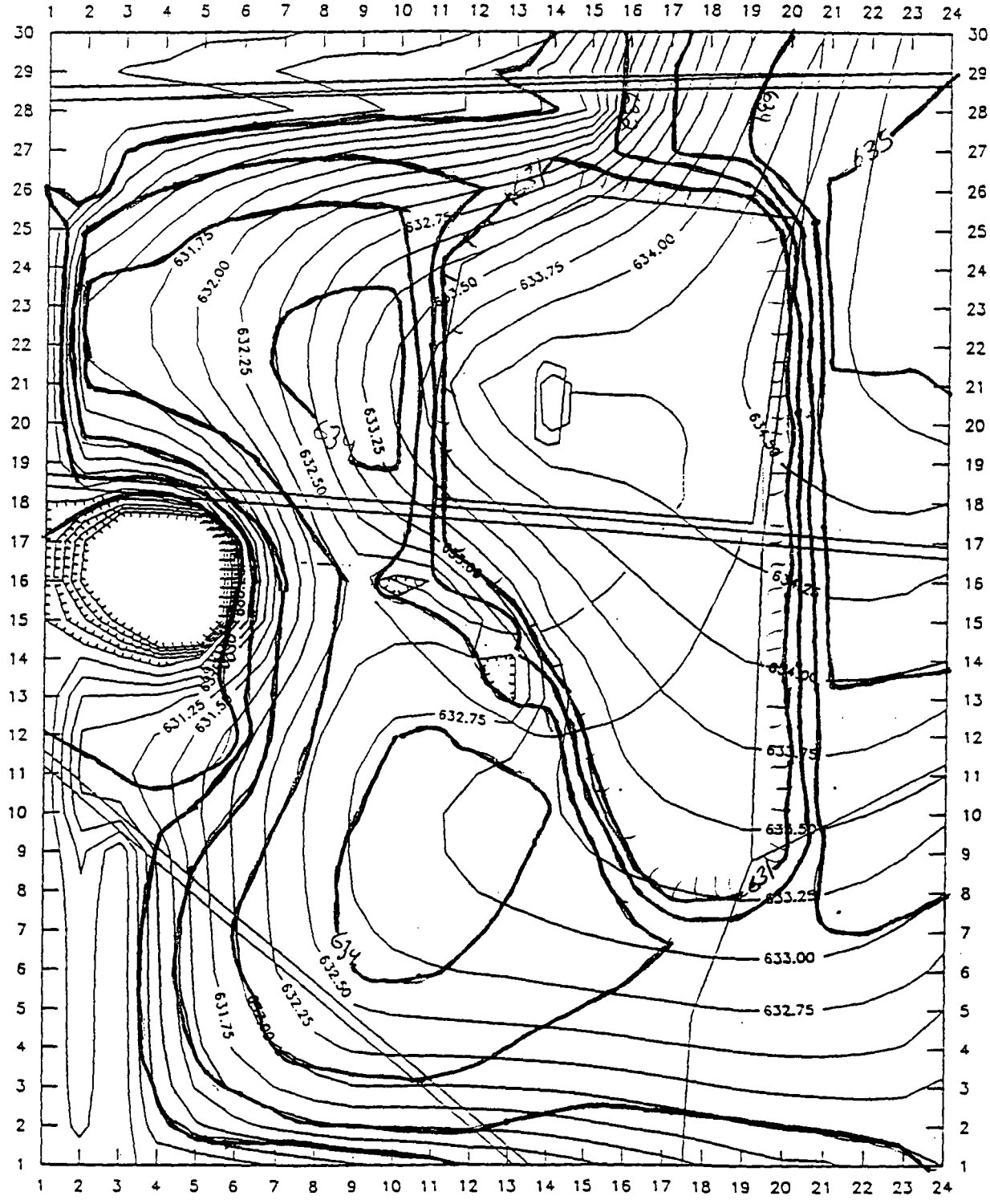


Figure 3

April 6, 1990
water level

REM2 -- 10e-6 cm/sec Slurry Wall - 1 year

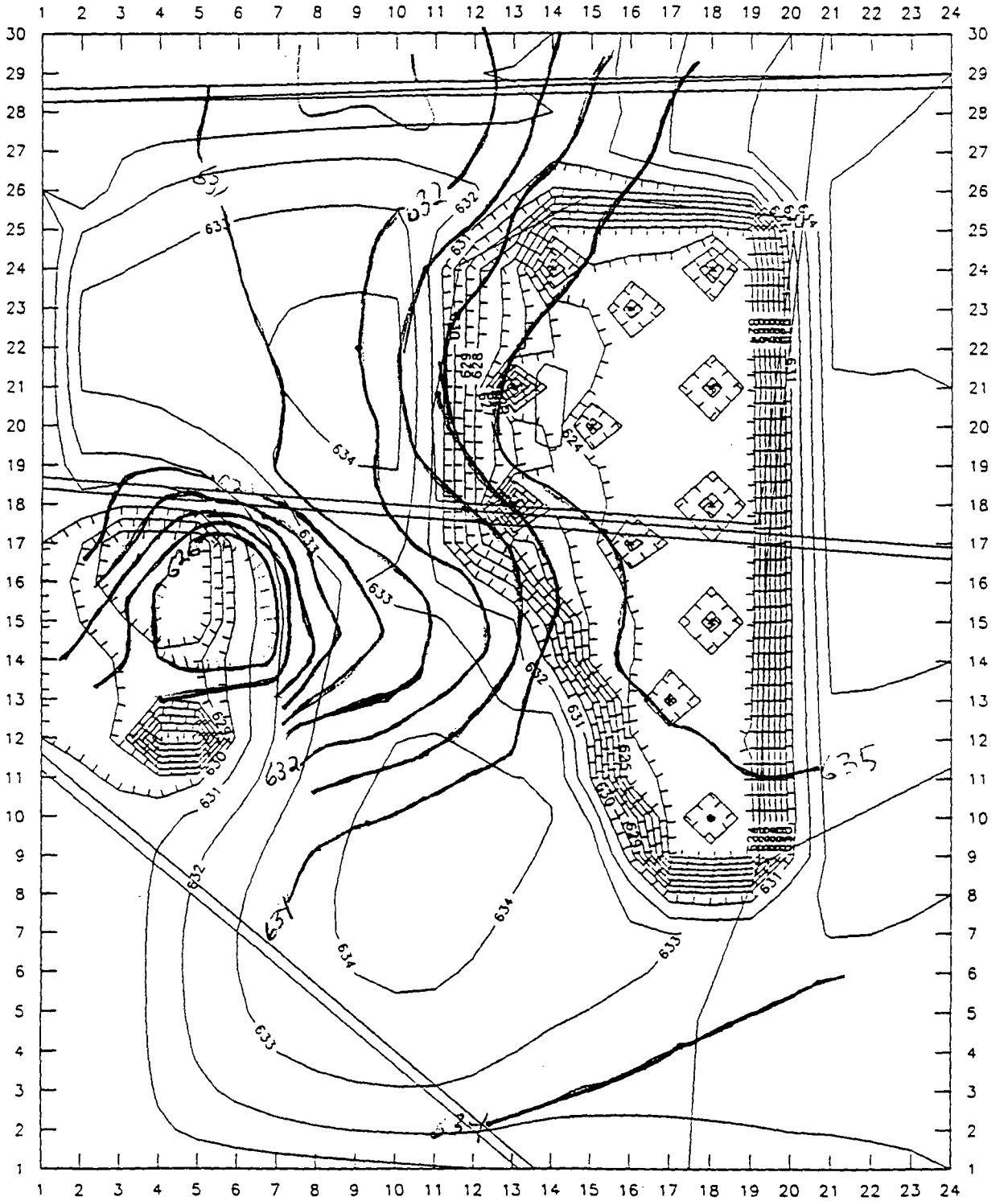


Figure 4

April 6, 1990
water level

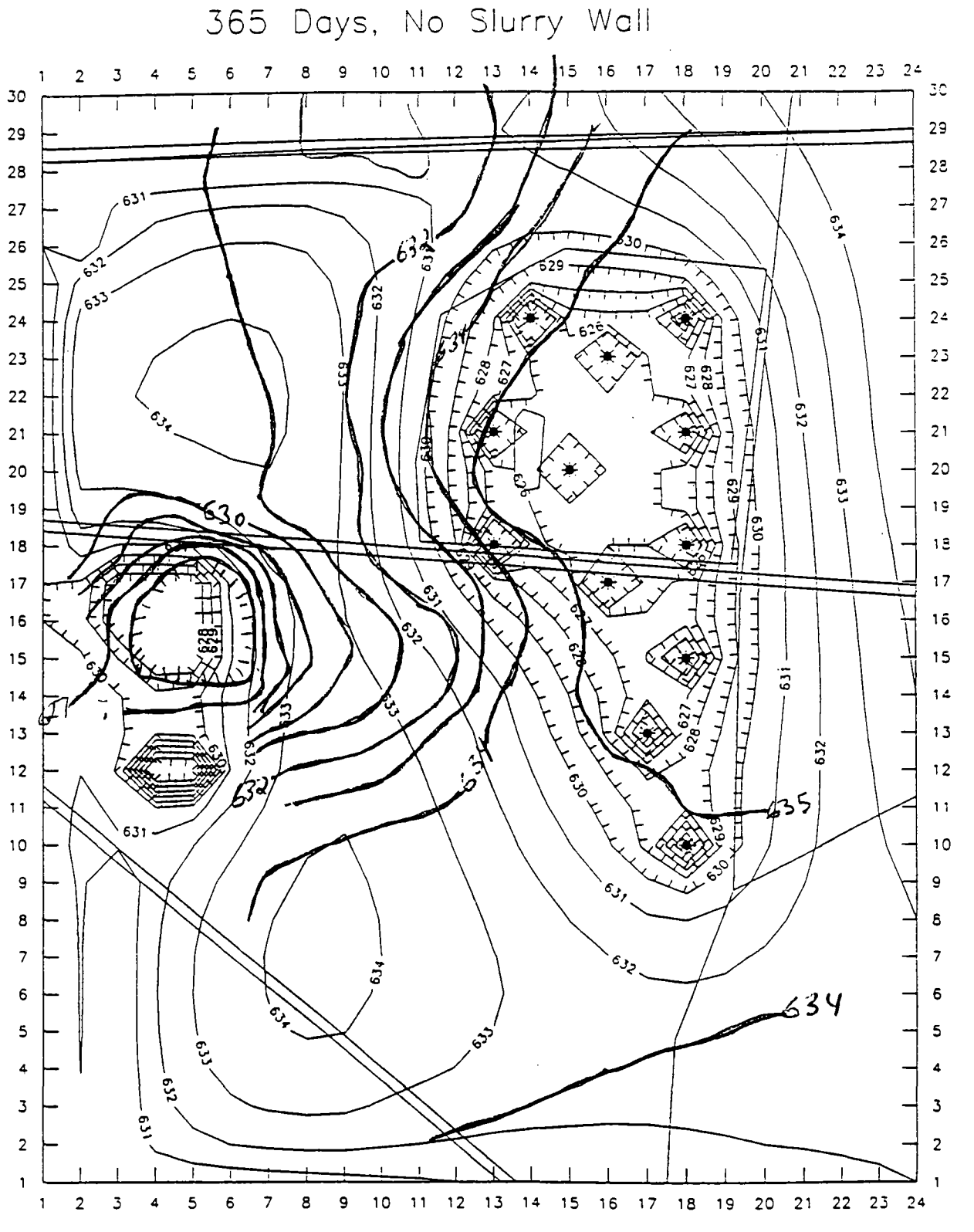


Figure 5